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ELECTROTECHNICAL VOCABULARY

PART 61 NUCLEAR MEDICAL INSTRUMENTS

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Indian Standard

ELECTROTECHNICAL VOCABULARY

PART 61 NUCLEAR MEDICAL INSTRUMENTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 8 March 1985, after the draft finalized by the Basic Electrotechnical Standards Sectional Committee in Consultation with Electromedical Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 Nuclear medical instruments generally consist of a collimator, a shielded radiation detector for converting the photon energy into electrical pulses, a mechanical, electronic or electromechanical system for obtaining position information, in the case of the imaging devices like scanners and gamma cameras, and electronic pulse processing devices like preamplifiers, amplifiers, pulse height analysers, scalers, timers count rate meters and display systems.

0.3 Lot of useful information has been taken from the draft Doc : 62C (Central Office) 5 of the International Electrotechnical Commission, Sensitivity and Resolution in Radio Isotope Scanning — Mac Intyre *et. al*, Proceedings and Symposium on Medical Radioisotope Scintigraphy Salzburg 6-15 August 1968, IAEA Vienna 1969 and nuclear medicine physics, instrumentation and agents F.D. Rollo. The C.V. Mosby Company, Saint Louis, 1977 and data supplied by Bhabha Atomic Research Centre, Bombay.

1. SCOPE

1.1 The purpose of this standard covers definition of the terms encountered in nuclear medical instruments. The nuclear medical instruments include uptake monitors, scanners and gamma cameras.

2. TERMINOLOGY

2.1 Activity — The activity, A, of a quantity of radioactive nuclide is the dN/dt, where dN is the expected number of spontaneous nuclear transformations which occur in this quantity in the time interval dt.

$$A = \frac{dN}{dt}$$

The term nuclear transformation is meant to designate a change of nuclide or an isomeric transformation.

2.2 Up-take — The ratio of actual counts per unit time excluding background from the object of interest to the actual counts per unit time excluding background from the radioactive dose to be administered keeping all counting parameters and the source geometry exactly same for both measurements. This is usually expressed as a percentage.

2.3 Scintigraphy — A procedure for producing an image of an invite radionuclide distribution.

2.4 Gamma Camera (Camera) — An instrument which produces an image by simultaneous detection of radiation emitted from all parts of the object included in the image.

2.5 Scanner — An instrument for conducting scintigraphy using a single or multiple radiation detector assemblies in which the image is formed due to relative movement of the radiation detector head and the object.

2.5.1 *Scan Field* — That part of a specified plane parallel to the plane of movement for which an image is formed.

2.5.2 *Scan Speed* — Speed of a detector head relative to the object being scanned.

2.5.3 *Scan Mode* — Indicates mode of scanning for example — bidirectional and unidirectional.

2.5.4 *Line Spacing* — The lateral displacement of the collimator axis between two successive scan lines.

2.6 Detector Head — The combination of the radiation detector assembly with collimator and detector shield.

2.6.1 *Radiation Detector Assembly* — An assembly which can produce electrical signals when ionizing radiation interacts with it. It does not include the collimator or detector shield.

2.6.2 *Detector Shield* — A component for attenuating radiation that does not pass through the collimator.

2.6.3 *Useful Detector Area (Camera)* — The area of the radiation detector over which a specified performance is achieved.

2.7 Collimator — A block of radiation attenuating material with one or more apertures that limit the angular spread of the radiation which can reach the radiation detector assembly.

2.7.1 *Collimator Front Face* — The surface of a collimator which is closest to the object.

2.7.2 *Collimator Back Face* — The surface of a collimator which is closest to the radiation detector assembly.

2.7.3 *Collimator Axis* — Straight line through the centre of the collimator and perpendicular to the collimator face.

2.7.4 *Parallel Hole Collimator* — Collimator with a number of a apertures, the axes of which are parallel. It is used in cameras.

2.7.5 *Converging Collimator* — Collimator with a number of apertures, the axes of which converge to a point in front of the radiation detector assembly. If the converging point is beyond the object it is used in cameras for image enlargement.

2.7.6 *Diverging Collimator* — Collimator with a number of apertures, the axes of which diverge from a point behind the radiation detector assembly. It is used in cameras for image minification.

2.7.7 *Pin Hole Collimator* — Collimator with a small aperture in front of the radiation detector assembly. It is used in cameras.

2.7.8 *Focussed Collimator* — Collimator with a number of apertures, the axes of which converge to a point (or set of points) on the collimator axis in front of the radiation detector assembly and within the object. It is used in scanners.

2.7.9 *Slit Collimator* — Collimator with a slit shaped aperture. It is used in profile scanning.

2.7.10 *Focussed Slit Collimator* — Collimator with a number of slit shaped apertures, the mid planes of which converge to a straight line (or set of staight lines) in front of the radiation detector assembly. The slits may be sub divided by parallel septa. It is used in scanners.

2.7.11 *Flat Field Collimator* — A single aperture collimator which gives a constant count rate response over a certain angle subtended at the centre of the crystal at a specified distance along the axis of the collimator. It is used in uptake measurements.

2.7.12 *Field of View* — The area of distribution of radio activity as seen by the detector.

2.7.13 *Geometrical Field af View* — It is the area of the distribution of radioactivity as seen by the detector, neglecting penetration and scatter, and is determined by geometrical considerations of collimator construction.

2.7.14 *Geometrical Radius of View* (*R*) — In the absence of septal penetration and scatter, the geometrical radius of resolution '*R*' of the collimator defines a circle from which the photons must originate if they are to interact with the detector.

2.7.15 *Geometrical Focal Distance(s) of a Collimator* — Distance(s) measured along the collimator axis, between the front face of focussed collimator and the point(s) or line(s) to which the axis or midplanes of the collimator apertures converge.

2.7.16 *Effective Focal Distance of a Collimator* — Distance measured along the collimator axis, between the front face of a focused collimator and the point on the collimator axis with minimum FWHM.

NOTE — The effective focal distance is not necessarily equal to the geometrical focal distance.

2.7.17 *Geometrical Focal Plane* — Plane perpendicular to the collimator axis at the geometrical focal distance.

2.7.18 *Effective Focal Plane* — Plane perpendicular to the collimator axis at the effective focal distance.

2.7.19 *Near Focus Limit* — Point nearest to the collimator front face on the collimator axis where the FWHM is double its minimum value or, if this point does not exist, the point of intersection of the collimator axis with the collimator front face.

2.7.20 *For Focus Limit* — Point farthest from the collimator front face on the collimator axis where the FWHM is double its minimum value.

2.7.21 *Depth of Focus* — Distance between the far and near focus limit.

2.7.22 *Collimator Geometric Efficiency* — It is the ratio of the rate of primary photons passing through the open space of the collimator to the rate of photons emitted by the source, in an idealized system.

NOTE — The open space of the collimator refers to the total area of detector exposed through the holes. This fraction is independent of the photon energy and is dependent only on geometrical considerations of collimator construction and thus neglects both scatter and saptum penetration.

2.7.23 *Septum* — The shielding material interspaced between apertures of the collimator.

2.8 Counting

2.8.1 *True Count Rate* — Count rate that would be observed if the resolving time (*see* **3.8.3**) of the device were zero.

2.8.2 *Count Rate Characteristic* — The function giving the relationship between observed and true count rate, when the true count rate is varied.

2.8.3 *Invivo Counter* — This refers to a counting system used to detect radioactivity emanating from inside the body.

In radiation medicine methods, a particular gamma emitting pharmaceutical is injected intravenously into the body, the radioisotope (tag or tracer as it is also called) follows the usual metabollic-biochemical-pathways and gets into an organ (for example, a liver). When such a subject is examined using a gamma scintillation counter (by taking the detector assembly nearer to the organ), the radioactivity emanating from the body can be detected.

2.8.4 *Invitro Counter* — Scintillation counter counts 'radioactivity from samples' of say blood, taken out of a patient. The sample is contained in a vial and the activity determined. Assessment of total activity is made from this estimate.

2.8.5 *Resolving Time of a Device* — The smallest time interval which must elapse between the occurrence of two consecutive input signals to the device in order that it be capable of performing its function for each of them separately.

2.8.6 *Resolution Time* — The limiting time which results in loss of counts when an attempt is made to count two closed spaced spikes is termed resolution time of the scintillation counter.

2.8.7 *Pulse-Height Analyzer* — It is an electronic device which allows counting of electrical pulses produced by gamma radiations falling within a selected energy range.

2.8.8 *Pulse High Analyzer Window* — The range of input signal amplitude (channel width) for which the analyzer delivers an output signal (channel output pulse).

2.8.9 *Pulse Higher Analyzer Base Line* — The level of the pulse amplitude above which only the analyzer is likely to give a channel output pulse.

NOTE — If the input pulse range is above the base line plus the channel width there will be no channel output pulse from the analyzer, for this range of input pulses.

2.8.10 *Percentage Window of Pulse Height Analyzer* — The width of the channel of the pulse height analyzer when it is calibrated as a percentage of the centre voltage. The channel covers equally below and above the centre voltage setting.

2.8.11 *High Voltage* — The voltage applied to the photomultiplier tube. This is also referred to as E. H. T. (Extra High Tension). The gain of the photomultiplier is very much sensitive to the high voltage applied.

2.8.12 *Amplifier Gain* — The ratio of the amplitude of the output pulse to the amplitude of the input pulse when the amplifier is operating in the linear range.

2.9 Display

2.9.1 *Dot Factor* — The count interval between two consecutive impressions on the dot scan.

2.9.2 *Information Density* — It is as index of the statistical content of an image and is defined as the number of counts recorded per unit scan area (counts/cm^2).

2.9.3 *Time Constant* -- It is a measure of the time taken by the count rate matter to record the count rate observed at a particular instant of time.

2.9.4 *Film Density* — It is a measure of the darkness produced on the film when it is exposed to light.

2.10 Sensitivity

2.10.1 *Plane Sensitivity* — With a specified collimator and pulse height analyzer window, the ratio of the count rate of the detector head to the activity per unit area of a standard plane source of a specified radio nuclide placed in air perpendicular to and centred on the collimator axis at a specified distance from the collimator front face.

2.10.2 *Line Sensitivity* — With a specified collimator and pulse height analyzer window, the ratio of the count rate of the detector head to the activity of a specified radio nuclide per unit length of a line source, placed in air perpendicular to and centred on the collimator axis at a specified distance from the collimator front face.

2.10.3 *Line Source* — Line source is as extended distribution of ratio activity in the shape of a line of minimum diameter and length greater than but not greatly exceeding the field of view of the detector.

2.10.4 *Line Spread Function* — Line spread function, $S_L (X, Z)$ is the variation of the senstivity S_L, with transverse displacement of the line source at a distance Z from the collimator front face.

2.10.5 *Full Width at Half Maximum (FWHM) of Line Spread Function* — The distance along the X-axis between the points where line spread fuction has half its maximum value.

2.10.6 *Detector Head FWHM* — Full width at half maximum of the line spread function of the detector head with a specified collimator.

2.10.7 *Index of Resolution* — The index of resolution of a system is defined as the FWHM of the detector head. The index of resolution must be measured at a specific distance, Z, between the source and collimator front face.

2.11 Modulation

$$\text{The quotient} = \frac{\text{max value} - \text{min value}}{\text{max value} + \text{min value}}$$

for a phenomenon that does not have negative values as in the case of the distribution of radioactivity in a plane source.

2.11.1 *Modulation Transfer Function* — The modulation transfer function is the fourier transform of the line spread function.

The function gives the variation in the ratio of the modulation of the measured quantity, for example, count rate of the detector head, to the modulation of a planer radioactive source, whose radioactivity is sinusodially modulated in one dimension of space, with the spatial frequency of the source. The spatial frequency, expressed as cycles/cm is the reciprocal of the distance between two neighbouring points of the same phase of a phenomenon that is modulated sinusodially in space.

2.12 Uniformity (Camera) — Uniformity is defined as the ability of the camera to produce a uniform image when the radioactive source provides uniform distribution of gamma rays over the detector of the camera.

2.13 Linearity (Camera) — Linearity is the ability of the camera to reproduce arrays of linear sources of radioactivity in a manner which conserves all the spatial and geometric relationship of the array.

2.14 Resolving Power (Camera) — Resolving power is the ability of the camera to display in the image certain closely-spaced differences in the levels of radioactivity in the source.

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